USING AN INDICATORS DATABASE TO MEASURE STORMWATER PROGRAM EFFECTIVENESS IN HAMPTON ROADS

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Abstract

The Hampton Roads Planning District Commission (HRPDC) has been working with the region's sixteen localities to develop a regional stormwater management program since 1996. The program focuses on activities that support the permit compliance efforts of the six communities with Virgina Pollutant Discharge Elimination System (VPDES) Stormwater System Permits, technical assitance to the region's non-permitted communities and regional education and training to support all of the communities. A set of regional stormwater management goals that guide the regional program has been developed. Adopted by the HRPDC, they are:

- Manage stormwater quantity and quality to the maximum extent practicable (MEP)
  - ---Implement Best Management Practices (BMPs) and retrofit flood control projects to provide water quality benefits.
  - ---Support site planning and plan review activities.
  - ---Manage pesticide, herbicide and fertilizer applications.
- Implement public information activities to increase citizen awareness and support for the program.
- Meet the following needs of citizens:
  - ---Address flooding and drainage problems.
  - ---Maintain the stormwater infrastructure.
  - ---Protect waterways.
  - ---Provide the appropriate funding for the program.
- Implement cost-effective and flexible program components.
- Satisfy VPDES stormwater permit requirements:
  - ---Enhance erosion and sedimentation control.
  - ---Manage illicit discharges, spill response and remediation.

The Regional Stormwater Management Committee determined that a major technical study should be undertaken cooperatively to support the stormwater programs of the six permitted localities and should include the following components:

1. Analyze stormwater discharge sampling data to develop event mean concentrations (EMC) by city and by land use.
2. Develop stormwater pollutant loads for watersheds in the six cities based on the EMC using a geographic information system.
3. Develop a consolidated regional monitoring program for the six cities for consideration by the Department of Environmental Quality (DEQ) in the VPDES stormwater permit reapplication process. Develop recommendations on indicators of stormwater management program effectiveness.

The Regional Loading Study recommended the use of a series of Program Effectiveness Indicators, rather than continued traditional chemical water quality monitoring. The HRPDC staff developed a proposed modification to the monitoring component of each locality's municipal separate storm sewer system (MS4) Permit, outlining the Regional Stormwater Management Program Goals that are to be met through the local stormwater programs and how the Indicators would be used to measure progress toward those goals. Ten indicators were developed to measure the overall success of local programs. The proposed Permit Modification was submitted by each of the permitted localities and was incorporated by DEQ into the reissued VPDES Stormwater Permits.

Background

During their first separate storm sewer system (MS4) Virginia Pollutant Discharge Elimination System (VPDES) permit term, the Cities of Chesapeake, Hampton, Newport News, Norfolk, Portsmouth, and Virginia Beach were required to monitor the chemical constituents from selected outfalls. Based on the collected monitoring data, the local governments were required to calculate Event Mean Concentrations (EMCs) of pollutants discharged from their monitored stormwater outfalls. A study was commissioned by the affected local governments to determine the efficacy of this method of monitoring. A map of the study area with major watersheds is included as Figure 1. The consultant on the project was charged with the following:

1. Analyze stormwater discharge sampling data to develop event mean concentrations (EMC) by city and by land use.
2. Develop stormwater pollutant loads for watersheds in the six cities based on the EMC using a geographic information system.
3. Develop a consolidated regional monitoring program for the six cities for consideration by DEQ in the VPDES stormwater permit reapplication process. Develop recommendations on indicators of stormwater management program effectiveness.

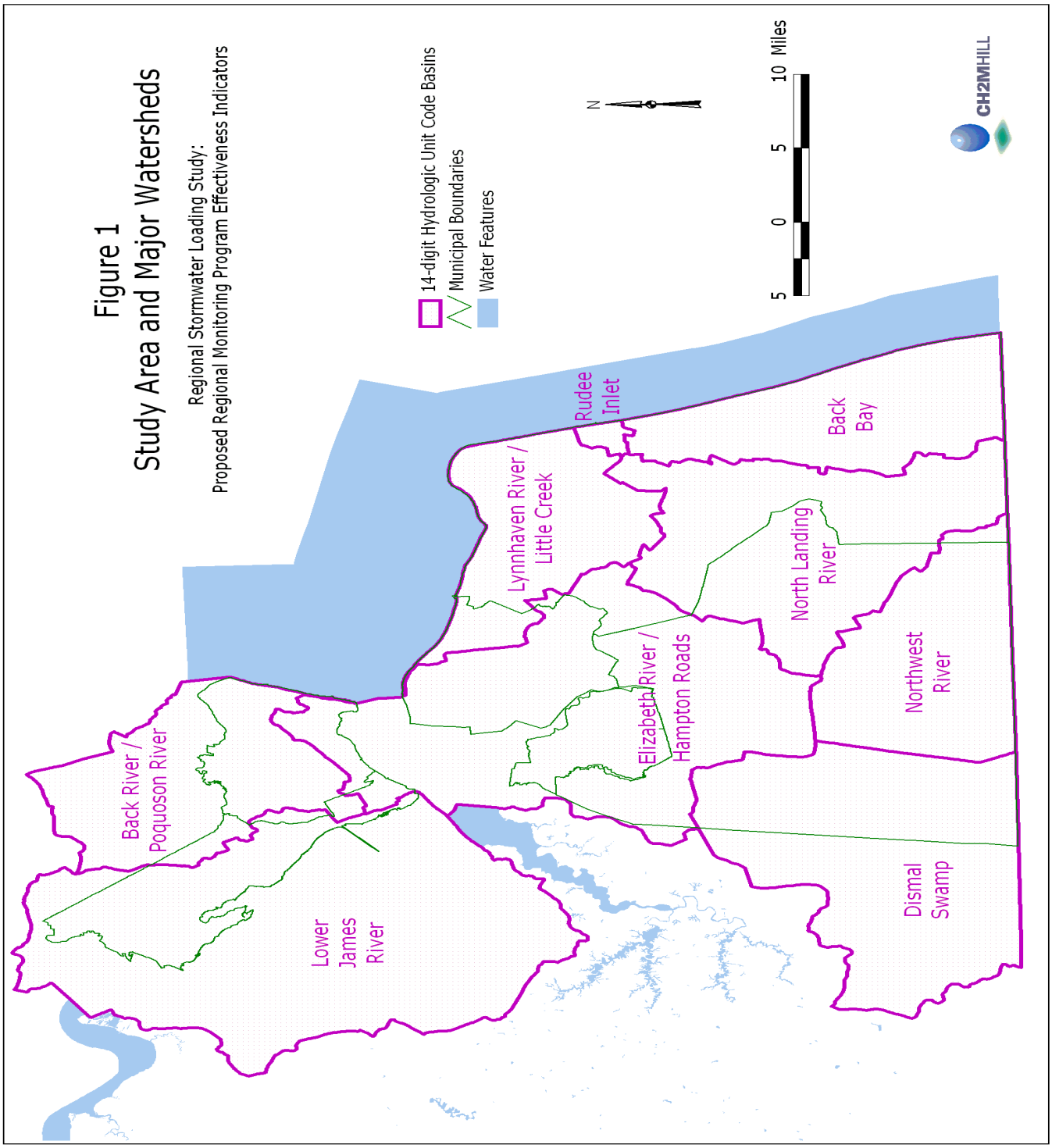

Figure 1: Study Area and Major Watersheds Map

Process and Objectives

The process for developing the regional stormwater program and effectiveness indicators is shown in Figure 2 and is described below:

- The consultant conducted a literature search of regional monitoring programs and alternative program effectiveness indicators.
- The consultant facilitated discussion of the development of regionally consistent stormwater monitoring program goals, prioritizing potential indicators to be used in a regional program, either to complement or replace the required chemical monitoring under the then existing VPDES permits. The goal setting and prioritization was conducted over a series of workshops from October 1998 to February 1999.
- The consultant performed an analysis of existing VPDES permit data to determine:
  - Whether chemical monitoring can be replaced by other effectiveness indicators, by comparing local data to the Nationwide Urban Runoff Program (NURP) data.
  - If monitoring cannot be replaced, determine whether monitoring sites and land use types can be consolidated based on representative data across cities and land use as compared with NURP data.

An important objective of the new program was to effectively communicate the successes of the municipal stormwater programs to the public and elected officials, with greater emphasis on social and programmatic indicators. A second objective was to develop a more cost-effective approach to stormwater monitoring in the Hampton Roads region that will both satisfy the permit requirements and measure the effectiveness of local stormwater programs.

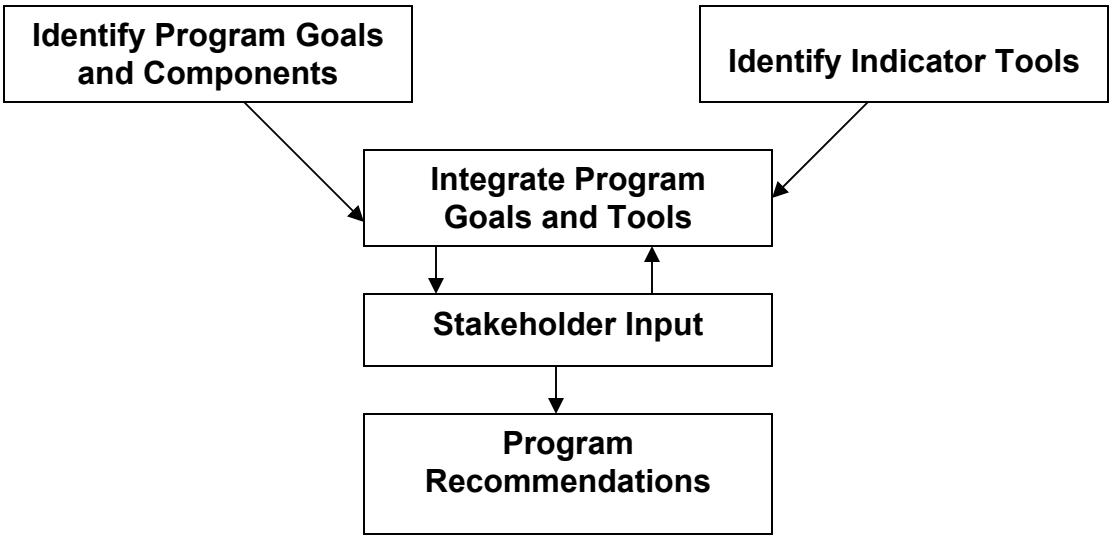

Figure 2: The Process

When compared to EMCs from other urban areas studied during the Nationwide Urban Runoff Program (NURP), calculations indicated that the level of pollutants carried by stormwater in Hampton Roads is typical of other urban areas and, in many cases, lower.

The Stormwater Management Program Effectiveness Indicator Tracking Program was developed to help the region's local governments assess their achievement of common stormwater management goals developed by the Hampton Roads Regional Stormwater Management Program. These goals are:

- Manage stormwater quantity and quality to the maximum extent practicable (MEP).
  - Implement BMPs and retrofit flood control projects to provide water quality benefits
  - Support site planning and plan review activities.
  - Manage pesticide, herbicide, and fertilizer applications.

- Implement public information activities to increase citizen awareness and support for the program.

- Meet the following needs of citizens:
  - Address flooding and drainage problems.
  - Maintain stormwater infrastructure.
  - Protect waterways.
  - Provide appropriate funding for the program.

- Implement cost-effective and flexible program components.

- Satisfy VPDES stormwater permit requirements.
  - Enhance erosion and sedimentation control.
  - Manage illicit discharges, spill response, and remediation.

The Indicators Program

A variety of program effectiveness indicators were selected during the series of workshops. These indicators encompass all aspects of local stormwater programs in Hampton Roads and were selected based upon technical, practical and programmatic considerations. To capture data representative of the activities in stormwater programs, the indicators were divided into strategic indicator groups. An indicator was defined as a measurable feature that provides managerially and scientifically useful evidence of stormwater and ecosystem quality or reliable evidence of trends in stormwater quality and program effectiveness. The Tracking Program stores the indicator data in a Microsoft Access database. The indicators that are recorded in the database can be grouped into one of four categories as illustrated in Table 1 below:

Table 1: Database Indicators

Indicator Group	Indicator
Water Quality	Pollutant Loadings
Physical & Hydrological	Greenlands Program
Programmatic	Investigative Monitoring BMP Implementation Flooding and Drainage Control Flooding and Drainage Projects Erosion and Sediment Control Permitting and Compliance Operations and Maintenance
Socioeconomic	Public Information Programs Environmental Knowledge Website visits Publications Distributed Media Restoration Activities Cleanup Activities

While the chemical monitoring program was useful in determining that the stormwater runoff in Hampton Roads is comparable to other urban areas, it was not useful in communicating the effectiveness of local stormwater management programs. The high variability of the data, due to natural factors such as rainfall, makes it very difficult to detect any actual increasing or decreasing trends in pollutant levels carried by stormwater runoff. In addition, the chemical monitoring program could not account for actions taken by local stormwater programs to reduce flooding and drainage problems. Due to these shortcomings, the permitted local governments of Hampton Roads proposed modifying their MS4 VPDES permits to replace the chemical monitoring requirement with a Stormwater Management Program Effectiveness Indicator Tracking Program for the second permit term. Initial data collection began in 2000 to provide examples of the types of data that would be collected in future years, should the Tracking Program be allowed in the permit renewal process. Data can be queried and illustrated by locality and regionally, in the form of

summary tables and graphs. The Virginia Department of Environmental Quality accepted the proposed Tracking Program in lieu of chemical monitoring and modified the MS4 VPDES permits accordingly when they were reissued in April 2001.

Description of Indicators

Water Quality Nutrient Loadings
CH2MHill estimated Stormwater pollutant loads for each of the local governments in Hampton Roads permitted through the Virginia Pollutant Discharge Elimination System Program. The estimated pollutant loads are documented in a series of Technical Memoranda contained in each locality's annual report.

Greenlands
Greenlands are lands that are permanently protected from development or lands that are restored to a more natural state during redevelopment. They provide a water quality benefit by reducing the imperviousness of the watershed. Such lands may include parklands, refuges, wetlands, and lands protected by conservation easement. The database is structured to maintain the number of acres of greenlands to assess progress toward reducing the potential watershed imperviousness and nonpoint source pollution loads.

BMP Implementation
Stormwater best management practices (BMPs) help to minimize flooding and water quality impacts associated with development. Experience has shown that over time, lack of maintenance has caused BMPs to lose their effectiveness. In addition, older developed areas lack BMPs or the designs of the BMPs that have been installed do not include water quality protection measures. To measure the success of BMPs in flood and water quality protection, the database is structured to include information on:

- The number and types of BMPs installed or retrofitted for water quality
- The number of developed acres served by BMPs, grouped by land use
- Inspection and maintenance activities

This information will eventually allow the estimation of pollutant removal by BMPs and the ascertainment of whether BMPs are functioning properly.

Erosion and Sediment Control
Every local government in the Commonwealth of Virginia is required to administer an Erosion and Sediment Control Program. The Erosion and Sediment Control Law requires that land disturbing activities exceeding 10,000 square feet submit an Erosion and Sediment Control Plan and meet minimum standards. Under the Chesapeake Bay Preservation Act, the threshold is decreased to 2,500 square feet in a Chesapeake Bay Preservation Area. The minimum standards specify practices that reduce the amount of sediment leaving a construction site and minimize downstream flooding and streambank erosion. The level of enforcement and compliance limits the effectiveness of local erosion and sediment control programs. To monitor the extent of land-disturbing activities, the database is designed to include information on the number of approved erosion and sediment control plans and disturbed acreage. The number of inspections and enforcement actions are also included to evaluate enforcement and the level of compliance with the local erosion and sediment control regulations.

Flooding and Drainage Responses
Calls and complaints received from citizens can be an indicator of the performance of a stormwater program. Responsiveness of a stormwater program, in the form of inspections and resulting maintenance

activities, to citizen inquiries can also be an indicator of effective administration of the stormwater program. The database is structured to collect data on the number of citizen calls and responses.

Flooding and Drainage Projects
An important function of a local stormwater program is to correct flooding and water quality problems. Projects to address these needs may be included in local Capital Improvement Projects. Corrective actions may involve retrofitting areas, installing BMPs, or restoration activities. To help determine whether a stormwater program is actively performing this important function, the database is designed to include the number and cost of flooding and drainage projects.

Investigative Monitoring
Hazardous material spills, wastewater cross connections, and other illicit discharges can represent a significant source of pollution. Implementing an effective illicit discharge/connection management program to control these sources can result in considerable improvements to water quality. The database is structured to allow the collection of information on investigative and corrective actions, to assess whether an illicit discharge/connection program is being effectively implemented. These actions include screening inspections and measures taken to locate and eliminate illicit discharges/connections.

Operations and Maintenance
Operation and maintenance activities are crucial to a stormwater conveyance system's ability to reduce flooding and minimize the amount of pollutants that are discharged into the region's waterways. Operation and maintenance activities include street sweeping and cleaning and repairing both catch basins and drainage facilities. By monitoring these activities, the proper functioning of the stormwater system can be assessed, and the amount of sediment that was prevented from being discharged by the stormwater system can be estimated.

Permitting and Compliance
Development increases the amount of runoff and pollution in a watershed. In an effort to monitor development activity, the number of approved site and subdivision plans, and their associated developed or redeveloped acres are maintained in the database.

Public Information Programs
Informing individuals about stormwater issues and measures they can take to reduce pollution is important to gaining public support of a stormwater program. It also helps protect water quality. The database maintains information on public education and outreach activities to help assess whether a stormwater program is adequately carrying out this function. The parameters that are examined include: number of publications produced and distributed, public outreach activities, media campaigns, riparian restoration activities by citizens, stream cleanup activities, and web site hits. Where appropriate, citizens are surveyed regarding their knowledge levels before and after an informational effort.

The Database

The Main Menu

The database opens up to the Main Menu with several selection options. The upper portion of the menu lists each of the effectiveness indicators. When an indicator is selected, a data entry form for that particular indicator is displayed.

The bottom portion of the menu consists of administrative functions. The "Edit Lookup Tables" button opens a form that allows the input of additional Activity Types, BMP Types, Green Areas, Municipalities, Pollutants, Spot Types, Topics and Watersheds. The "Import/Export Data" button opens a form that will allow each of the indicators to be exported in a text or Excel format, as well as import an indicator that has already been exported in a text format by using this tool. The Main Menu is illustrated in Figure 3.

Figure 3: Database Main Menu

Indicator Tools Menus

Data entry forms are set up for each indicator to facilitate the data-gathering task. Few of the permitted localities have all of the tracked information in one department. The Tracking Program allows data entry to be conducted by several departments, compiled by the respective locality, and then compiled for the region. Many localities are able to use the data gathered in reporting on other related program efforts such as Erosion and Sediment Control and the Chesapeake Bay Preservation Act.

Features unique to the Tracking Program include the ability to query for reporting by region, watershed or locality. Data can also be entered in the datasheet view, which allows for full functionality of all of the

associated pull-down menus. The Tracking Program also allows for different time intervals of data collection, such as monthly, quarterly or annually, ensuring flexibility for the different local programs.

Localities can also customize specific reporting areas to more accurately capture local program efforts by utilizing the Edit Lookup Tables function of the database. Existing lookup values can be added, deleted or modified based on local program needs.

An Import/Export Data function allows electronic compilation and transfer of data between and among local departments, as well as to and from the HRPDC staff. The data can be exported and manipulated in Excel or exported to text to send a final version. Filenames are automatically assigned by concatenating the municipality with the table name and current date. When importing data, automatic integrity checks will be activated which prevent duplicate reporting, while allowing the user to upload the remaining records.

Sample Reports

Figure 4 and Figure 5 show examples of reports for Pollutant Concentrations (EMCs) and Pollutant Loading data.

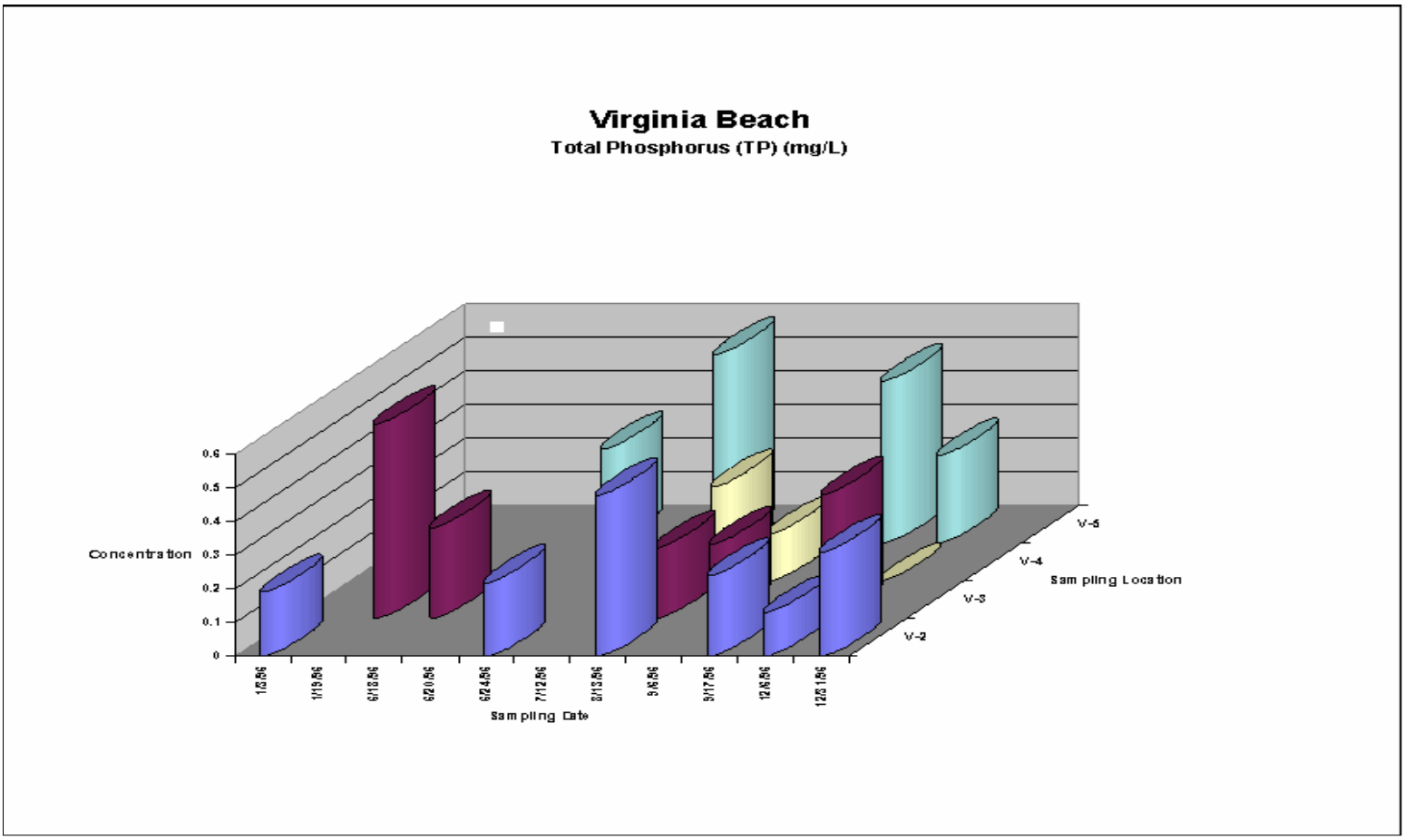

Figure 4: Pollutant Concentration Data for Virginia Beach

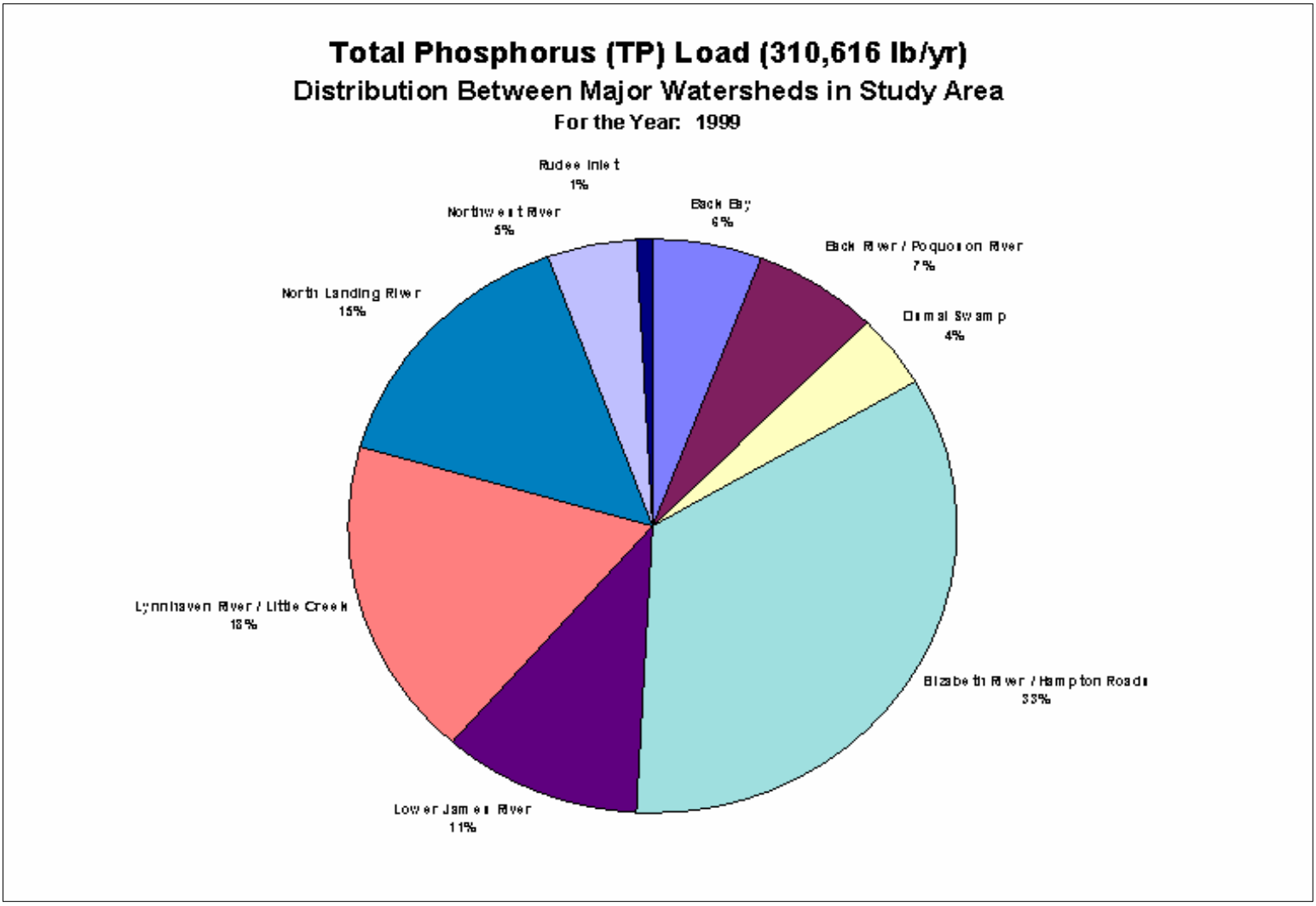

Figure 5: Total Phosphorus Load Distribution by Major Study Area Watersheds

A variety of reports can be generated from the myriad of data collected. Data can be sorted by locality, watershed, activity type, watershed within a specific locality, or summarized for the entire Hampton Roads region. Some examples of those tables and charts follow:

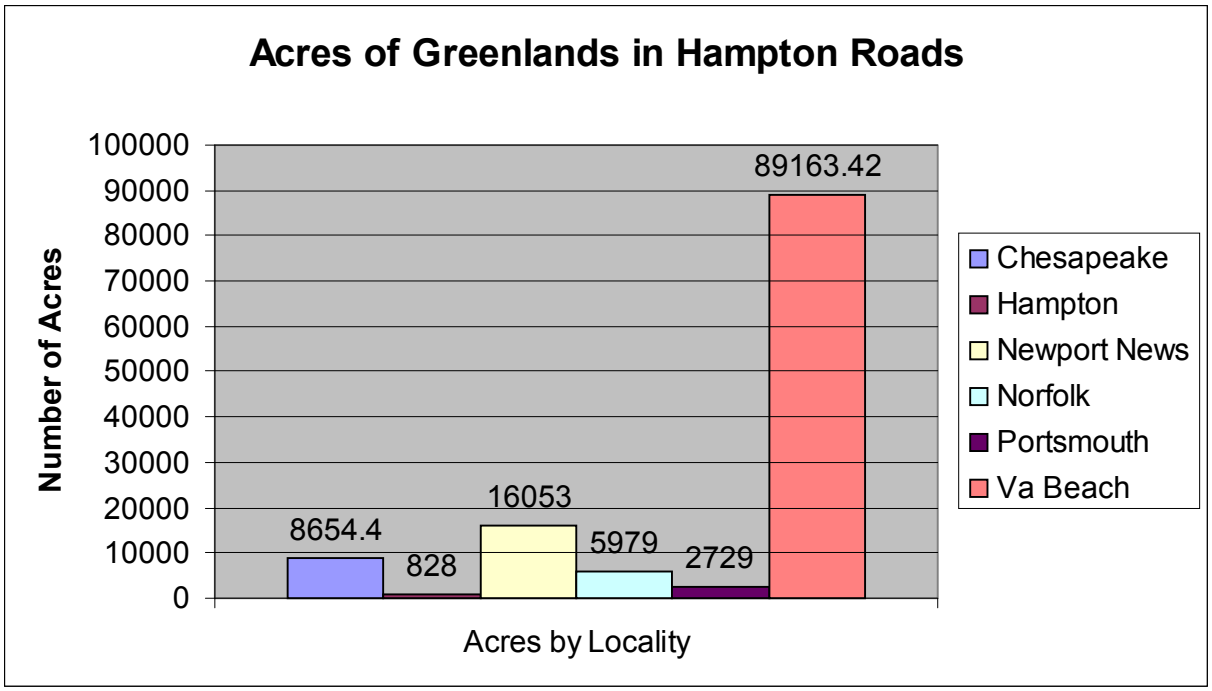

Figure 6: Acres of Greenland Areas in Hampton Roads

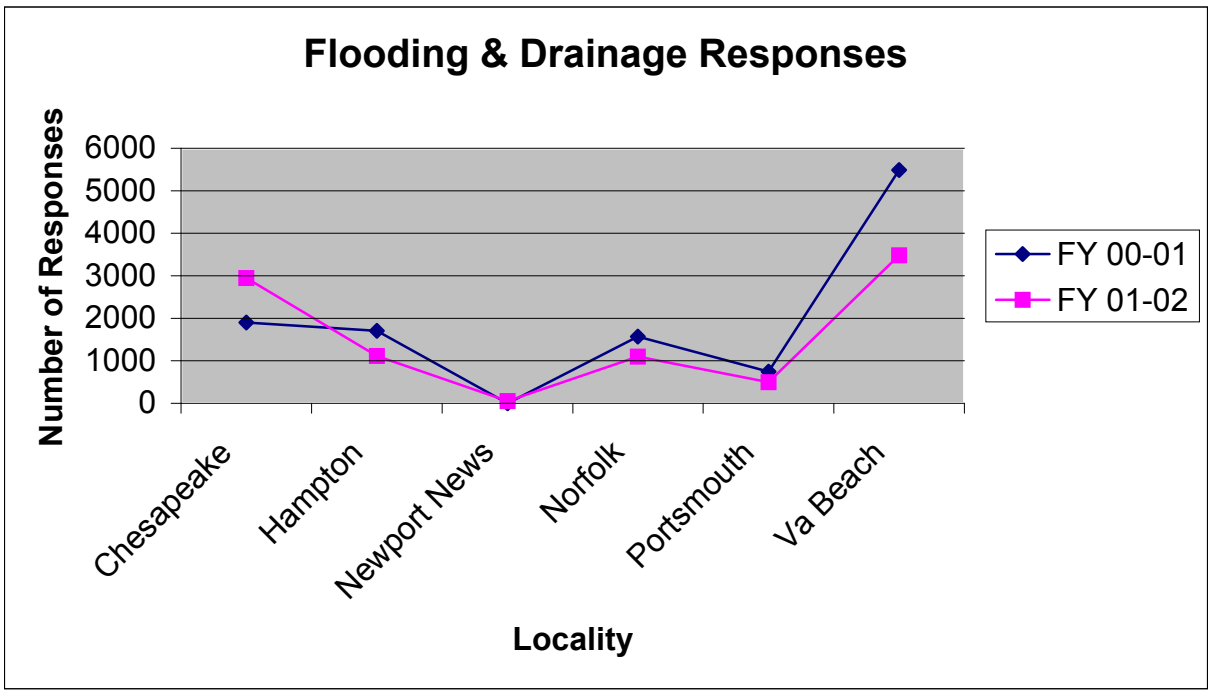

Figure 7: Flooding and Drainage Responses by Fiscal Year per Locality

Table 2: Miles of Drainage Facilities Serviced

Miles of Drainage Facilities Serviced		
	FY 00-01	FY 01-02
Chesapeake	933	97.41
Hampton	405	325
Newport News	13880	242
Norfolk	11.14	199.9
Portsmouth	109	504
Va Beach	9	92

Table 3: Street Sweeping Miles and Tons Recovered

Street Sweeping FY 01-02		
	Miles	Tons
Chesapeake	6218.85	870
Hampton	715	2663
Newport News	12004	9378
Norfolk	50700	7245
Portsmouth	17073	653
Va Beach	10350	15646

These various indicator groups, while not complete unto themselves, can together give a better indication of the success of an overall storm water management program. The data is also helpful to local governments in evaluating annual budgets; compiling long-term budget and program priorities for permit renewal; and having hard data to share with citizens and elected officials. A challenge of the tracking program has been keeping the data input consistent between and among localities, as often several staff members will be responsible for entering various pieces of the data for their locality. The goal of the reports is not to compare program weaknesses between localities, but rather to more effectively gauge local efforts and spending in relation to program accomplishments.

Conclusion

Trial data was submitted to DEQ prior to formal permit renewal applications being submitted. During that time, work sessions were also held with the committee to gauge the usefulness and efficiency of the Indicator Tracking Program and to look at data management areas that needed enhancements or refinements. Local government and HRPDC staff responsible for technical and educational efforts participated in these sessions. Since inception, the tracking program has undergone several updates. This will be the first full permitted program year for reporting the data gathered by the Tracking Program for the Phase I communities.

In the recently enacted federal Phase II Stormwater Regulations, the U.S. Environmental Protection Agency recognizes the shortcomings of chemical monitoring. Rather than conduct a chemical monitoring program, Phase II communities are required to track the implementation of stormwater management measures. These management measures include public education and outreach, public involvement, illicit discharge detection and elimination, construction site runoff, post-construction runoff, and pollution prevention/good housekeeping activities. The Phase II Regulations recognize that this kind of tracking system provides a better measure of program effectiveness than chemical monitoring of stormwater outfalls. This is great justification of what was proposed for Phase I communities.

The Stormwater Management Program Effectiveness Indicator Tracking Program is similar to the tracking system required by the Phase II Stormwater Regulations. It is expected that the Stormwater Management Program Effectiveness Indicator Tracking Program will also be used by the local governments of Hampton

Roads affected by the Phase II Regulations to satisfy their permit requirements. This may require further enhancement of the program to assist smaller localities with data gathering tasks.

We anticipate further update to the database, as well as a series of training sessions for local users. While the tracking program allows the HRPDC to generate consist reports for all participating localities, challenges remain in getting data input that is consistent between and among localities.

In addition, the basic Tracking Program has been submitted as a suggested beginning model for discussions regarding consolidated tracking and reporting tasks that are typically required by various state agencies to meet program requirements.

References

CH2MHill, 1999. Regional Stormwater Loading Study, Proposed Regional Monitoring Program and Program Effectiveness Indicators.

CH2MHill, 2000. Proposed Regional Monitoring Program, Stormwater Effectiveness Indicators, Database User's Guide Version 1.

Hampton Roads Planning District Commission, 2002. Indicators of Stormwater Effectiveness Fiscal Year 2000-2001.